Residential Duct Insulation

Revised Cost Effectiveness Analysis

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Prepared for
California Energy Commission

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Background

Based on the original life cycle cost (LCC) analysis completed in 2002[1], the previous draft standards included raising the prescriptive R-factor for ducts in unconditioned spaces from the current R-4.2 to R-8 in Climate Zones 1 through 5 and 9 through 16. An important input to that analysis was data from manufacturers indicating that the cost of increasing the duct R-factor from 4.2 to 8 was $108 for the 1761 ft2 prototype. This cost estimate did not include either an increase in labor cost or savings in HVAC system costs due to improved on peak efficiency.

Industry Comments

On May 8, 2003 CEC staff and consultants had a conference call with a group representing insulation manufacturers, home builders, mechanical contractors and others to discuss the R-8 insulation proposal. There was general agreement in the group that the original LCC analysis underestimated the first cost of increasing duct R-values. The home builders and contractors in the group maintained that installation of R-8 flex ducts is more labor intensive and the LCC analysis should include a substantial added labor cost for this reason. The group agreed that R-6 flex ducts have a much smaller additional labor cost than R-8. A second important input was that R-6 duct board used to make fittings and plenums cost over twice as much as R-4.2 duct board. Many in the group stated that R-8 duct board was not available through their normal supply channels at any price. A large part of the estimated added labor costs for R-8 duct systems was due to the requirement for wrapping R-4.2 fittings and plenums with additional insulation in the field to meet the R-8 requirement.

Comments to the contrary were later received from 2 HVAC contractors in Oregon where there is a mature market for R-8 duct systems because that level has been a prescriptive requirement for new residential construction for many years. One contractor said that he charged 25% more for R-8 duct systems than R-4.2 systems. The other said that he has standardized on R-8 and uses it even in non residential projects where it is not required because the difference in his cost is so small it is not worth stocking R-4.2 components. These Oregon comments can be interpreted to mean that the current California costs will change substantially once higher duct insulation levels are required in the state and become typical industry practice.

Non-Flex Components

The industry comments on the problems of providing higher R-value fittings and plenums focused our attention on those non-flex duct components. Based on an informal industry survey we estimate that non-flex duct components make up 15% of the surface area of both the supply and return ducts. This part of the system includes air handler cabinets, plenums, splitter boxes, and boots. The cost of increasing the R-value of this part of the system is much higher per square foot of surface area than the cost of increasing the R-value of the flex duct portions of the system. However, 85% of the savings previously estimated can be realized by upgrading the flex duct portions of the system alone. The proposed Residential ACM accommodates this situation by allowing builders using the performance approach to specify R-4.2 for non-flex duct portions of the system and assume that is 15% of the duct system area in both the Proposed and Standard design.

1 Measure Analysis and Life-Cycle Cost, Part III, July 3, 2002, http://www.energy.ca.gov/2005_standards/documents/2002-07-18_workshop/2002-07-18_ELEY_REPORT.PDF, pp 17-21.

Revised Cost Estimate

Revised cost estimates for increasing flex duct insulation including additional labor costs are shown in Table 1. The original cost estimates are shown for comparison.

Table 1 -- Cost of Increased Duct Insulation

Insulation	**Increased Cost to Home buyer for 1761 ft2 prototype**	
R-value	**Original Estimate**	**Revised Estimate**
R-6	$65	$100
R-8	$108	$600

Revised Life Cycle Cost Analysis

Life cycle energy cost savings for attic ducts were recalculated using the standard LCC approach[2], proposed ACM rules and assuming that 85% of the surface area of the duct system was upgraded. Table 2 shows the savings for the flex duct upgrade from R4.2 to R-6. Table 3 shows the savings for the upgrade from R-4.2 to R-8.

Table 2 -- Life Cycle Energy Cost Savings for Upgrade from R-4.2 to R-6 Duct Insulation

	TDV LCC Approach		
CTZ	**Gas**	**Elect**	**Total**
1	138	0	$138
2	163	59	$222
3	92	15	$107
4	115	15	$130
5	102	10	$112
6	38	18	$56
7	36	8	$43
8	41	26	$66
9	51	64	$115
10	64	122	$186
11	145	133	$278
12	128	82	$209
13	102	163	$265
14	173	209	$383
15	23	515	$538
16	375	48	$424

[2] Life Cycle Cost Methodology, California Energy Commission, P400-02-009, March 11, 2002, http://www.energy.ca.gov/2005_standards/documents/2002-04-02_workshop/2002-03-20_LIFE_CYCLE.PDF

Table 3 -- Life Cycle Energy Cost Savings for Upgrade from R-4.2 to R-8 Duct

	TDV LCC Approach		
CTZ	**Gas**	**Elect**	**Total**
1	222	0	$222
2	263	94	$357
3	151	26	$176
4	181	26	$207
5	166	18	$184
6	59	26	$84
7	56	13	$69
8	66	41	$107
9	82	102	$184
10	102	194	$296
11	230	212	$441
12	207	133	$339
13	163	263	$426
14	278	334	$612
15	38	824	$862
16	594	79	$674

Comparison of the costs from Table 1 with the savings from Tables 2 and 3 shows that the total life cycle savings is greater than the insulation added cost estimate of $100 for R-6 ducts in climate zones 1-5 and 9-16. Similarly, a comparison of the $600 cost for R-4.2 to R-8 with the total savings in Table 3 shows that the upgrade to R-8 is also cost effective in climate zones 14, 15 and 16. Based on this analysis we propose the prescriptive package D insulation requirements for all ducts in unconditioned spaces shown in Table 4.

Table 4 -- Proposed Prescriptive Duct Insulation Requirement

	Duct Insulation R-value
CTZ	**Total**
1	6
2	6
3	6
4	6
5	6
6	4.2
7	4.2
8	4.2
9	6
10	6
11	6
12	6
13	6
14	8
15	8
16	8